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## CALCULUS.

**395. Proposed by W. W. BURTON, Mercer University, Macon, Ga.**

Into a full conical wine glass whose depth is  $a$  and whose angle at the base is  $2\alpha$  there is carefully dropped a spherical ball of such size as to cause the greatest overflow. Show that the radius of the ball is  $a \sin \alpha / (\sin \alpha + \cos 2\alpha)$ .

From Woods and Bailey's *A Course in Mathematics* (1907), Volume I, page 213.

**396. Proposed by ELBERT H. CLARKE, Purdue University.**

The length of the curve  $y = x^n$  from the origin to the point  $(1, 1)$  is given by the formula

$$l = \int_0^1 \sqrt{1 + n^2 x^{2n-2}} dx.$$

Our geometric intuition would tell us that the limit of this length as  $n$  becomes infinite is 2. Give a strict analytic proof that

$$\lim_{n \rightarrow \infty} \int_0^1 \sqrt{1 + n^2 x^{2n-2}} dx = 2.$$

## MECHANICS.

**315. Proposed by H. S. UHLER, Yale University.**

A solid, homogeneous, right, circular cylinder is allowed to move from rest down a circular cylindrical track which is concave upwards. Find the ratio of the radius of the track to the radius of the cylinder when the time of descent through a finite arc to the bottom is the same for the extreme cases of no slipping and zero friction. Show also that the same relation holds for a sphere descending a cylindrical or spherical surface.

**316. Proposed by C. N. SCHMALL, New York, N. Y.**

A body at rest at a point  $R$  begins to move towards a center of force  $F$ . The distance  $RF = d$ , and the force varies inversely as the distance. Two intermediate points in the path are  $P$  and  $Q$ , such that  $FP = kd$ , and  $FQ = k^nd$ . Show that the body will traverse the distance  $QP$  in a maximum of time if  $k = 1/n^{2(n-1)}$ .

## SOLUTIONS OF PROBLEMS.

## ALGEBRA.

**426. Proposed by HERBERT N. CARLETON, West Newbury, Mass.**

Find all solutions of the equation

$$x^{\frac{x}{\sqrt{x}}} = x^x.$$

SOLUTION BY J. A. CAPRON, Notre Dame, Ind.

The equation may be written in the form  $x^{1+(1/x)} = x^x$ , or  $x^{(x+1)/x} - x^x = 0$ . Factoring, we have  $x^x [x^{(x+1-x^2)/x} - 1] = 0$ . This equation is equivalent to the two equations  $x^x = 0$  and  $x^{(x+1-x^2)/x} - 1 = 0$ . The first of these equations is satisfied for the value of  $x = -\infty$ . From the second equation, we have, by taking logarithms, the equation

$$\left( \frac{x+1-x^2}{x} \right) \log x = 0.$$

This equation is equivalent to the three equations  $1/x = 0$ ,  $x+1-x^2 = 0$ , and  $\log x = 0$ . From the first of these equations,  $x = \pm \infty$ ; from the second,  $x = (1 \pm \sqrt{5})/2$ ; and from the third,  $x = 1$ .